LAYING OUT LOW SAR PIFA ANTENNA FOR CELLULAR GADGET

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ABSTRACT

Cellular telecommunication is widely spreading around the world. Mobile handsets are often used in the vicinity of the human head. The continuous growth of wireless mobile services has forced the worldwide mobile handset manufacturers to consider the mutual interactions between the mobile terminals and human .The performance of mobile is altered due to the proximity of the human head due to SAR.Specific Absorption Rate (SAR) is a parameter which define the quality of the device lower is the value of SAR higher is the efficiency and lesser effects of RF on human body.The simplest method to significantly reduce SAR values is increasing the distance between the human head and the mobile handset antenna but using Planar Inverted F-Antenna (PIFA) is considered as one of the most appropriate antenna structures to reduce the SAR Now, the fourth generation of mobile communications, the Long Term Evolution (LTE), is expected to deliver multimedia services as a result usage and health risk has increased.This paper presents a novel and simple PIFA design for Long Term Evolution (LTE) mobile phone application.. The antenna consists of a rectangular planar element located above the Flame Retardant 4 (FR4) dielectric substrate. The ground plane is on the bottom side of the substrate. Total dimension of PIFA is 23.72 mm x 18.5 mm x 4mm and has been optimized to cover the LTE Band 7 application at 2600 MHz frequency. This antenna is suitable for mounting on the mobile phone due to its low profile, small size, and good gain. The proposed antenna is simulated using by CST Software. Its performance in term of return loss, VSWR, Gain and SAR.

INTRODUCTION:

The continuous growth of wireless mobile services has forced the worldwide mobile handset manufacturers to consider the mutual interactions between the mobile terminals and human body. On the one hand, part of the electromagnetic wave radiated by the antenna is absorbed by the human head. On the other hand, some mobile handset antenna characteristics, such as radiation pattern, radiation efficiency, bandwidth, and return loss, are altered due to the proximity of the human head. The mutual effect between the human head and the antenna have been investigated by many researchers. The Specific Absorption Rate (SAR) is a defined parameter for evaluating the power absorption in human tissue. To protect the users from hazardous RF exposure, safety guidelines or limits of SAR have been made by Federal Communication Commission (FCC). According to IEEE, SAR is the time derivative of the incremental energy absorbed by (dissipated in) an incremental mass contained in a volume element of given density (ρ) . The SAR limit is set at 2W/kg over any 10g of tissue according to IEEE C95.1:2005. This limit is comparable to the limit specified by the International Commission on Non-Ionizing Radiation Protection guidelines. Planar Inverted F-Antenna (PIFA) is considered as one of the most appropriate antenna structures for mobile handset application due to many advantages including: low profile, simple structure, and reasonable antenna performance. PIFA structure is also attractive for designing multi-band antennas. These antennas are becoming essential for modern wireless communication systems. There are many methods proposed to PIFA structure to reduce SAR levels. The simplest method to significantly reduce SAR values depends on increasing the distance between the human head and the mobile handset antenna . This can be achieved by the application of back mounted antenna for mobile handset or by profiling the handset. Other researchers try to reduce the radiation to human head by attaching a particular material to the antenna or mobile handset. Ferrite material has been an attractive material in reducing the SAR values . The effect of ferrite sheet attachment to mobile handset was also investigated by Wang et al. in 1999. The experiment is done using portable phone with a monopole antenna. The current from monopole antenna flows on all surfaces of the

box. The ferrite sheet is used to suppress the current flowing in the handset box resulting in a significant reduction of the SAR without altering the antenna performance.

Recently, the communication technologies have a rapid growth in such a way that it allows mobile phone to be operated in various communication services. This has led to a great competition for designing antennas with some desirable features such as multiband operation, light weight, low SAR and low profile. Nowadays, the fourth generation of mobile communications, the Long Term Evolution (LTE), is expected to deliver multimedia services anywhere, anytime. The LTE standard is scheduled to operate in different frequency bands that range from 400MHz to 4GHz with bandwidths of 1.4 and 20MHz.

As the usage of the mobile phone is increased, the research on the health risk due to the electromagnetic (EM) fields generated from wireless terminals is widely in progress. Many factors may affect the EM interaction while using cellular handset in close proximity to head and hand. The specific absorption rate (SAR) is defined as a figure of merit to evaluate the power absorbed by biological tissues. Growing consumer demand for multifunctional mobile handsets has seen an increase in the development of small multi-band antennas. It seems to be highly desirable to develop lightweight, low-profile and single feed mobile antenna, which can be used simultaneously in different frequency ranges and for different mobile services. The ability to cover a number of communication bands with one small antenna benefits both the end user and the manufacturer as it reduces the cost and complexity of the antenna system and allows more versatile function of a compact handset. In addition, the handset can be made more attractive to the consumer by reducing the radiation absorbed in the head.PIFA is formed from a linear Inverted F antenna (IFA) where the wire radiator element of IFA is replaced by a plate to enhance the bandwidth performances. The PIFA have some unique characteristic that makes it suitable for use in portable wireless device especially on mobile handsets. It has several advantages compared than other microstrip antennas. It has a low profile, small size and can locate in structure such as at the back cover of the mobile phone . The other major compensation is it is easy to fabricate, low manufacturing cost, and simple structure. It also has low SAR value where it has a small backward radiation toward the user's head and reducing the electromagnetic wave power absorption and increase the antenna performance.

But, conventional PIFA has some disadvantages which are it has narrow bandwidth, cannot support multi frequencies simultaneously and low antenna efficiency . The PIFA consists of three main elements which is rectangular planar located above a ground plane (top radiating patch), a short circuiting wall or plate and a feeding technique for the planar element. The feeding mechanism that suitable used in PIFA design is coaxial probe where the 50 Ω SMA connector is used and insert on to the top radiating patch. In PIFA design, the short circuiting plate is used in order to reduce the height of the antenna. It is also important in order to connect between the ground plane and top radiating patch. More and more communication standards are introduced every day and they are required to be supported by handsets. This recent growth and rapid development of mobile communication and introduction of new frequency bands and services has lead to the requirement of antennas with multiband operation

This paper presents a novel and simple PIFA design for Long Term Evolution (LTE) mobile phone application. The PIFA design will exhibit a single band frequency and resonate at 2.6 GHz and the bandwidth is 120 MHz. All the proposed idea is tested through simulation on an FR4 microstrip substrate of characteristics: $\varepsilon r = 4$, $h = 1.6$ mm and $\tan \delta = 0.02$. The proposed PIFA design and results will be discussed in detail in this paper.

In this paper, the proposed PIFA design consists of five basic elements which are a metallic ground plane, a resonating metallic plane, a substrate separating the main radiation patch and ground plane and the shorting plate (wall) with height, H. The feeding mechanism used in this proposed antenna is a probe feed method where the 50 Ω SMA connector is used to feed the rectangular patch antenna. The advantage of PIFA is compact, low profile and easy to manufacture [9]. On the other hand, Planar Inverted-F Antenna

(PIFA) designs are widely employed for mobile terminals including mobile handsets, wearable devices and sensors. In this paper, we apply the selective antenna area miniaturization design approach to derive a multi-zone PIFA structure for mobile devices.

LITERATURE SURVAY:

H. F. Abutarboush, R. Nilavalan, and D. Budimir proposed the "Design of Planar Inverted-F Antennas (PIFA) for Multiband Wireless Applications,"A small three bands printed inverted-F antenna with independently controlling the resonant frequency is presented. The proposed antenna consists of two arms supported by shorting walls fed by 50 Omega microstrip transmission line and a ground plane**.**The simulated and measured results show that the antenna achieves a gain of 2, 3 and 5 dBi respectively and radiation efficiency of 50%, 60% and 85% for the three bands respectively. The simulated and measured result for the return loss is in good agreements.

N. A. Saidatul, A. A. H. Azremi, R. B. Ahmad, P. J. Soh, and F. Malek proposed the "Multiband Fractal Planar Inverted F Antenna (F-Pifa) For Mobile Phone Application," A novel fractal planar inverted F antenna (F-PIFA) based on the self affinity design is presented in this paper. The F-PIFA has a total dimension 27 mm × 27 mm are designed and optimized in order to receive GSM and UMTS.The antenna achieved the GSM, UMTS and HiperLan frequency with -6 dB return loss and has almost omnidirectional radiation pattern. This antenna has been tested using mobile phone model and all the performance met the criteria for a mobile phone application

C.R. Rowell and R.D. Murch proposed "A compact PIFA suitable for dualfrequency 900/1800-MHz operation,"Planar inverted F antennas (PIFA) have been proposed as possible candidates for mobile telephone handsets. We describe the design of a compact PIFA suitable for operation at 900 MHz. In addition, we provide modifications to this design that allow it to operate in dual-frequency bands at 300 and 1800 MHz. Finite-difference time-domain (FDTD) and experimental results are provided.

Belhadef, Y.; Boukli Hacene, N., proposed "PIFAS antennas design for mobile communications," These antennas have for principal advantages, their compactness and their weak manufacturing costs, in addition to their significant performances. In this article, we present new geometries for this antenna type. The element feed is carried out by means of a coaxial probe. The suggested structure design, starting from a simple PIFA antenna, by HFSS and IE3D software makes it possible to have Bi-bands, tri-bands and quadribands antennas

A. Sayem, M. Douglas, G. Schmid, B. Petric, and M. Ali, proposed"Correlating Threshold With Free-Space Bandwidth for Low-Directivity Antennas," This paper develops a threshold power rationale that can be used to demonstrate inherent compliance for portable wireless devices with specific absorption rate (SAR) limits over the 300 - 6000 - MHz frequency range. This is achieved first by understanding the relationship between basic antenna parameters and SAR It is demonstrated that the derived threshold power is conservative for all of the low-directivity antennas studied. Computed results are

also compared against practical device data to show that the predicted threshold power data using the proposed formula are conservative.

IEEE Std C95.1-2005, proposed "Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz,". IEEE Standard, 2006 Recommendations to protect against harmful effects in human beings exposed to electromagnetic fields in the frequency range from 3 kHz to 300 GHz are provided in this standard. These recommendations are intended to apply in controlled environments and for general population exposure. These recommendations are not intended to apply to the exposure of patients by or under the direction of physicians and medical professionals.

PROPOSED WORK:

Growth of wireless mobile services has forced the worldwide mobile handset manufacturers to consider the mutual interactions between the mobile terminals and human bod and part of the electromagnetic wave radiated by the antenna is absorbed by the human head. On the other hand, some mobile handset antenna characteristics, such as radiation pattern, radiation efficiency, bandwidth, and return loss, are changed due to the vicinity of the human head. The mutual effect between the human head and the antenna has been investigated by many researchers.Planar Inverted F-Antenna (PIFA) is considered as one of the most appropriate antenna structures for mobile handset . PIFA which first appeared in the IEEE literature by the year 1987 emerged as one of the most promising candidate in this category of low profile antennas in last three decades . However it has a narrow bandwidth and needs a height from ground to substrate for matching and additional shorting pins near the feed to reduce the size of antenna . The proposed antenna has resonant frequency of 2.6GHz. PIFA design for LTE Band 7 (2500-2690MHz) with resonant frequency of 2.6GHz. The bandwidth of this proposed PIFA is about 120 MHz.using a CST DESIGN STUDIO

CST STUDIO SUITE likewise incorporates a block based schematic tool, CST DESIGN STUDIO™ (CST DS). And in addition offering circuit simulation, CST DS additionally enables models to be connected together and simulated, utilizing System Assembly and Modeling (SAM)to develop a perplexing framework from simpler components.

Dimension of PIFA Design:

Parameters	Values(mm)
L1	23.72
L2	18.5
H1	0.035
Lg	70
Wg	30
Hg	0.035
W	18.5
H	4
Ls1	4.75
Ls	70

Hs	1.6
Ws	30

L1=Length of radiating patch

L2=Width of radiating patch

Lg=length of ground plane

Wg=width of ground plane

W=width of sorting plate

H=height of radiating patch from ground plane

Ls1=spacing length

H1=height of radiating patch

Hg=height of ground plane

Ls=length of substrate

Ws=width of substrate

Hs=height of substrate

SIMULATION AND RESULTS

Create Reports:

4.1 Create Terminal S-Parameter Plot-Magnitude:

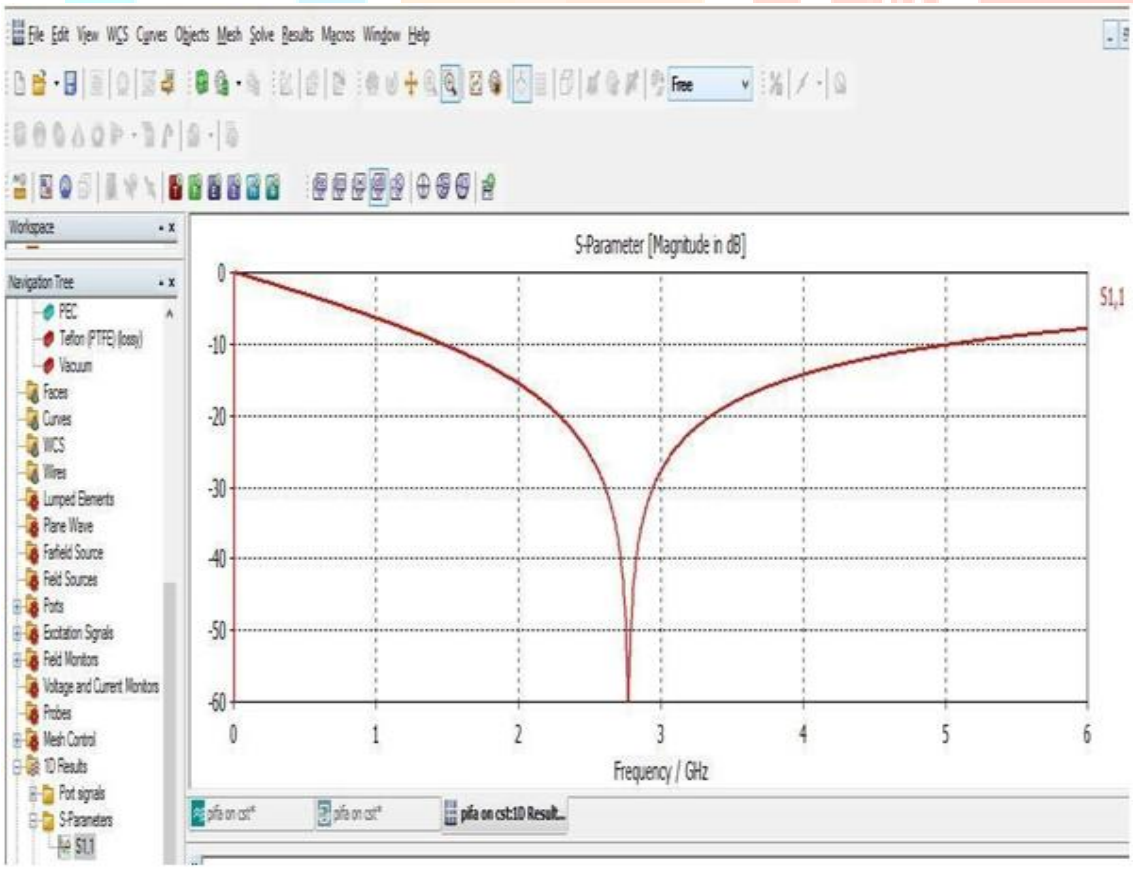

Fig 4.1 Plot of return loss

4.2 Create Terminal VSWR Report:

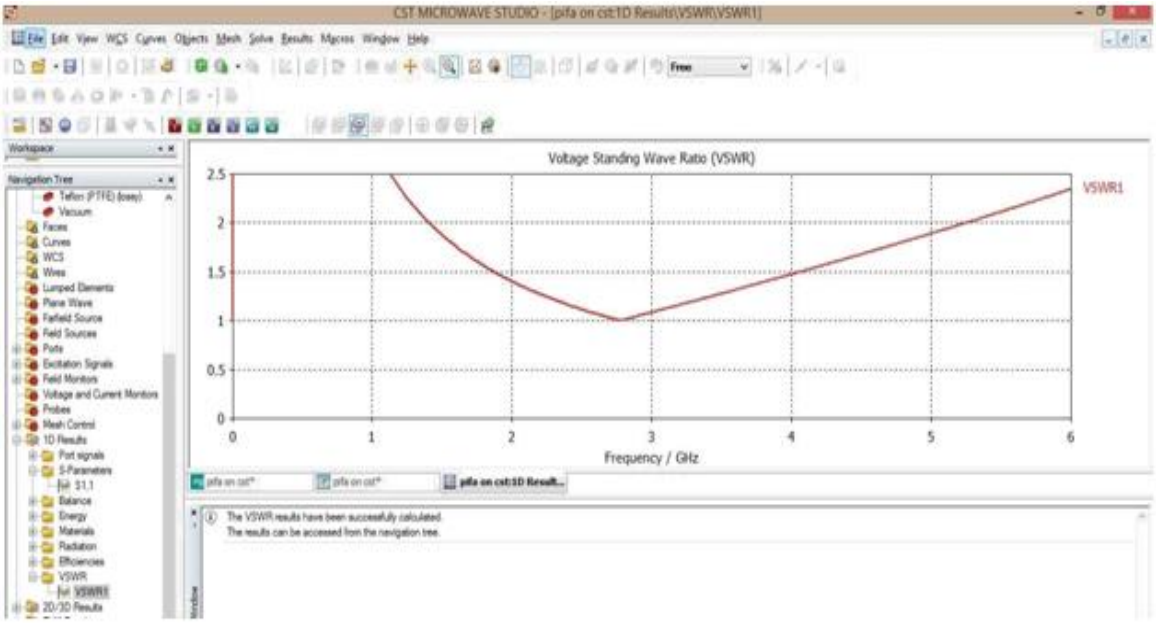

Fig 4.2 Plot of VSWR

4.3 Create the report of SAR:

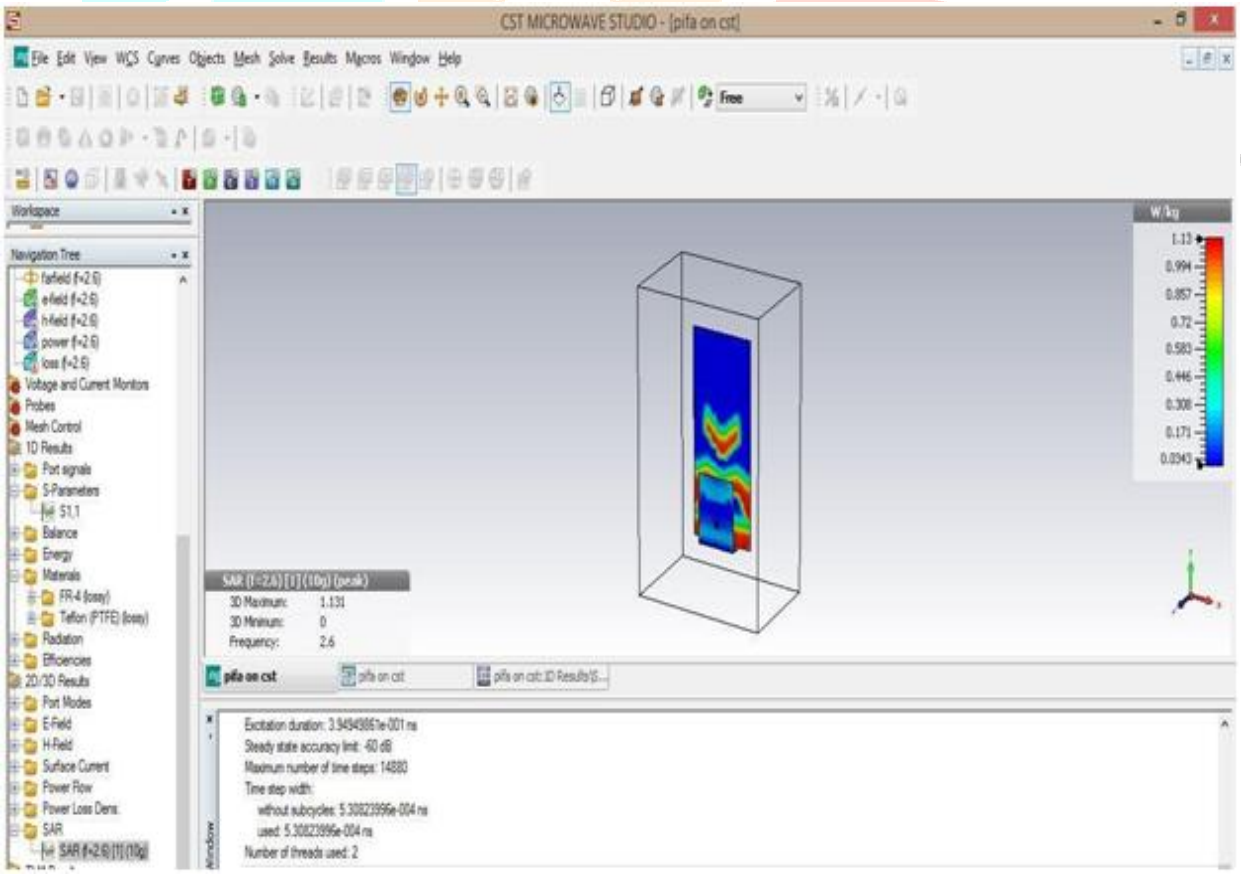

Fig 4.3 plot of SAR value

CONCLUSION:

The low SAR antenna was effectively designed by using appropriate methods. The factors that persuade the SAR were analyzed and by considering those factors, the SAR level of the antenna was reduced. The designed antenna also operated at 2.6 GHz frequency and had an omni directional radiation

pattern. In addition, this antenna is suitable for LTE applications. Parameters such as the amount of shielding sheet, feed position, and electrical parameters of tissues may all have significant effects on the resulting SAR. Also, increased distance between the radiating element and head can significantly reduce SAR. As a result, by implementing these simple and easy methods, the SAR of an antenna can be reduced and it possibly could be implementing to the mobile devices in the market. It is established that the novel design of the low SAR antenna does not debase its RF performance though has a great improvement of lessening the SAR level inside the user's head.

For wireless communication, we requires a low cost and high performance antenna. The PIFA Antenna has preferences of desired cross polarization with a specific end goal to receive both horizontal and vertical polarization, easy feeding, simple to fabricate and easy to place in mobile terminal as its size is less. It has less spurious radiation towards user head.

In this paper, the design of single band PIFA with rectangular top patch was presented and proposed.

The proposed antenna is used for LTE mobile phone application at 2.6-2.69 GHz. This PIFA could produce higher bandwidth by using several methods.

One of the methods is by increasing the height, H of the air gap between the ground plane and top radiating patch.

The proposed PIFA produced a good impedance bandwidth with of 120 MHz with the height, H is 4 mm and the gain is 3.4 dB.

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